



# **PUBLIC HEALTH STATEMENT**

## **Perfluoroalkyls**

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**Division of Toxicology and Environmental Medicine**

**May 2009**

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This Public Health Statement is the summary chapter from the Toxicological Profile for Perfluoroalkyls. It is one in a series of Public Health Statements about hazardous substances and their health effects. A shorter version, the ToxFAQs™, is also available. This information is important because these substances may harm you. The effects of exposure to any hazardous substance depend on the dose, the duration, how you are exposed, personal traits and habits, and whether other chemicals are present. For more information, call the ATSDR Information Center at 1-800-232-4636.

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This public health statement tells you about perfluoroalkyls and the effects of exposure to them.

Thirteen perfluoroalkyls are discussed in this profile. The names of these perfluoroalkyls are as follows: perfluorooctane sulfonic acid (PFOS), perfluorooctanoic acid (PFOA), perfluorododecanoic acid (PFDoA), perfluorodecanoic acid (PFDeA), perfluorobutyric acid (PFBA), perfluoroheptanoic acid (PFHpA), perfluorononanoic acid (PFNA), perfluoroundecanoic acid (PFUA), perfluorohexane sulfonic acid (PFHxS), perfluorobutane sulfonic acid (PFBuS), perfluorooctanesulfonamide (PFOSA), 2-(N-methyl-perfluorooctane sulfonamide) acetic acid (Me-PFOSA-AcOH), and 2-(N-ethyl-perfluorooctane sulfonamido) acetic acid (Et-PFOSA-AcOH). Seven of these substances are perfluoroalkyl carboxylic acids (PFOA, PFDoA, PFDeA, PFBA, PFHpA, PFNA, and PFUA), three are perfluoroalkyl sulphonic acids (PFOS, PFHxS, and PFBuS), and three are perfluoroalkyl sulfonamides (PFOSA, Me-PFOSA-AcOH, and Et-PFOSA-AcOH).

When a substance is released either from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. Such a release does not always lead to exposure. You can be exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance, or by skin contact. Most human exposures to perfluoroalkyls are to PFOA and PFOS. Most human exposures to perfluoroalkyls are expected to be through contaminated food and drinking water.

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If you are exposed to perfluoroalkyls, many factors will determine whether you will be harmed. These factors include the dose (how much), the duration (how long), and pathway (how you contact the perfluoroalkyls). Other important factors are any other chemicals you are exposed to, your age, sex, diet, family traits, lifestyle, and state of health.

### 1.1 WHAT ARE PERFLUOROALKYLS?

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| <b>Description</b>   | <p>Perfluoroalkyls are stable chemicals made of a carbon chain surrounded by fluorine atoms and an acid or amide group located at the end of the carbon chain.</p> <p>These substances are unique because they repel oil, grease, and water.</p>   |
| <b>Uses</b> <ul style="list-style-type: none"><li>• <b>Manufacturing</b></li></ul> | <p>Perfluoroalkyls have been made in large amounts in the United States. PFOA and PFOS are the two perfluoroalkyl compounds made in the largest amounts.</p> <p>PFOS and PFOA each had a reported produced volume between 15,000 and 500,000 pounds during 2002.</p> <p>Over the past several years, facilities either have stopped production or have begun changing manufacturing practices to reduce releases and the amounts of these chemicals in their products.</p> <p>Perfluoroalkyls have been used in surface protection products such as carpet and clothing treatments and coatings for paper and cardboard packaging.</p> |
| <ul style="list-style-type: none"><li>• <b>Consumer products</b></li></ul>         | <p>Perfluoroalkyls have been used in fire-fighting foams.</p> <p>Some facilities have announced that they will begin replacing many of the perfluoroalkyls that have been used in the above applications with other substances.</p>  |

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### 1.2 WHAT HAPPENS TO PERFLUOROALKYLS WHEN THEY ENTER THE ENVIRONMENT?

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| <b>Releases to the environment</b>  | <p>Perfluoroalkyls are not found naturally in the environment, but are there because of the action of humans. Perfluoroalkyls can be released into the environment when facilities and people use products that contain them. Perfluoroalkyls have been released into the environment near facilities that made or used these substances, and in many cases, contaminated the groundwater. These types of releases appear to be decreasing based on reports provided by these facilities.</p> <p>Perfluoroalkyls may be formed in the environment when other related chemicals degrade.</p> |
| <b>Break down</b> <ul style="list-style-type: none"><li>• <b>Air</b></li><li>• <b>Water</b></li><li>• <b>Soil</b></li></ul> | <p>Perfluoroalkyls break down very slowly in air, but are expected to fall out of the air to the ground within days to weeks.</p> <p>Perfluoroalkyls are very stable in water and are not known to break down in water. These chemicals may be carried over great distances by ocean currents.</p> <p>Perfluoroalkyls are not known to break down in soil. These substances may be carried through soil by groundwater.</p>   |

### 1.3 HOW MIGHT I BE EXPOSED TO PERFLUOROALKYLS?

Perfluoroalkyls have been widely found in human blood, indicating that human exposure to these substances is common.

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| <b>Air</b> | <p>Perfluoroalkyls have been found in both air and dust.</p> <p>You may be exposed to perfluoroalkyls by breathing air containing these substances. Ingestion of dust may also be a source of exposure.</p> |
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| <b>Water and soil</b>             | <p>Perfluoroalkyls have been found in surface water, groundwater, soil, and sediment, especially near facilities that have made or used these substances. They have also been found at remote locations such as the Arctic and the open ocean.</p> <p>Drinking water contaminated with PFOA released from a nearby fluorochemical facility was found to be a major source of exposure to that substance.</p> <p>Perfluoroalkyls have also been detected in bird eggs, fish, polar bears, etc.</p> |
| <b>Food and human breast milk</b> | <p>In addition to drinking water, food is expected to be an important source of exposure to perfluoroalkyls based on the amounts found in food samples.</p> <p>Human breast milk may contribute to the exposure of infants to perfluoroalkyls since these substances have been detected in human breast milk.</p>   |
| <b>Consumer products</b>          | <p>Perfluoroalkyls have been widely used in many consumer products (see Section 1.1).</p> <p>The presence of these substances in carpet treatments could be an important source of exposure to perfluoroalkyls, especially for children.</p>  |
| <b>Workplace</b>                  | <p>People who work where perfluoroalkyls are made or used may be exposed to these substances.</p> <p>Levels of PFOS and PFOA measured in the blood of some people who have worked at these locations were higher than levels in people from the same communities who did not work at these locations.</p> <p>Workplace exposure may also occur for people with jobs that require frequent handling or use of perfluoroalkyls.</p>   |

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### 1.4 HOW CAN PERFLUOROALKYLS ENTER AND LEAVE MY BODY?

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| <b>Enter your body</b> <ul style="list-style-type: none"><li>• <b>Inhalation</b></li></ul> | When you breathe air containing perfluoroalkyl compounds, some will enter your body through your lungs, but there is limited information on how fast, how much, or what specific perfluoroalkyl may preferentially enter the body.   |
| • <b>Ingestion</b>   | Perfluoroalkyl compounds in food or water may enter your body through the digestive tract.   |
| • <b>Dermal contact</b>  | If your skin comes into contact with dusts or aerosols of perfluoroalkyl, or with liquids containing perfluoroalkyls, it is possible that a small amount may enter the body through your skin.   |
| <b>Leave your body</b>   | Once in your body, perfluoroalkyls tend to remain unchanged for long periods of time. The most commonly used perfluoroalkyls (PFOA and PFOS) stay in the body for many years. It takes approximately 4 years for the level in the body to go down by half, even if no more is taken in. It appears that, in general, the shorter the carbon-chain length, the faster the perfluoroalkyl leaves the body. PFOA, PFOS, PFHxS, and PFNA are measureable in the serum of most U.S. citizens. |

### 1.5 HOW CAN PERFLUOROALKYLS AFFECT MY HEALTH?

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| <b>Workers</b>            | Inhalation/dermal—Long-term exposure to perfluoroalkyls at work has not been associated with significant adverse health effects, but two studies in workers found changes in sex hormones and cholesterol associated with the levels of PFOA in blood.  |
| <b>General population</b> | <p>Little research has been done on the general population to answer the question of whether perfluoroalkyls may be associated with adverse health effects.</p> <p>Ingestion—A single study of people whose drinking water contained perfluoroalkyls did not find problems in a number of clinical measures tested. The study did not, however, examine developmental risks for children or cancer. The 326-person study was too small to address these issues.</p> |

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| <b>Laboratory animals</b> | <p>One way to learn about the effects of perfluoroalkyls is to see how they affect test animals.</p> <p>Inhalation—Short-term exposure of rats to very high levels of PFOA has caused irritation of the eyes and the nose.</p> <p>Short-term exposure of rats to lower levels of PFOA caused damage to the liver and weight loss.</p> <p>Ingestion—Feeding food or capsules containing perfluoroalkyls to animals mainly produced alterations in the liver of the animals. It also reduced their growth, possibly because these chemicals affect the way the body processes food the animals eat.</p> <p>Dermal—Short-term application of large amounts of PFOA to the skin of animals has caused skin irritation and changes in the liver. These liver effects indicate that PFOA can be absorbed into the body through the skin and affect other parts of the body.</p> |
| <b>Cancer</b>             | <p>The information available does not prove that perfluoroalkyls cause cancer in humans, but the evidence is not conclusive. Some increases in prostate and bladder cancer have been seen, but the cause is not certain.</p> <p>Feeding PFOA and PFOS to rats caused them to develop tumors. Some scientists believe that based on the way this happens in rats, and the differences between rats and humans, humans would not be expected to get cancer. Others believe that it is possible for perfluoroalkyls to cause cancer in humans, and the studies in rats should not be dismissed. More research is needed to clarify this issue.</p> <p>The International Agency for Research on Cancer and the Department of Health and Human Services have not yet evaluated the carcinogenicity of perfluoroalkyls. The EPA has begun an evaluation.</p>                    |

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### 1.6 HOW CAN PERFLUOROALKYLS AFFECT CHILDREN?

This section discusses potential health effects in humans from exposures during the period from conception to maturity at 18 years of age.

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| <b>Effects in children</b> | <p>A study of people, including children, in an area of southeastern Ohio, whose drinking water was contaminated with PFOA found no short-term adverse health effects associated with PFOA. However, the study found the highest levels of PFOA in the blood of young children and older adults. The study did not look for cancer or delays in childhood development. The levels of PFOA in the blood from these people were much higher than those found in the general population of the United States.</p> <p>Three studies of pregnant women found that as the levels of PFOA in the mother's blood increased there was a tendency for the newborn babies to have slightly lower birth weight. However, another study that looked at exposure to PFOA in drinking water did not find such an association. Based on both animal and human study reports, developmental effects are the greatest concern in regards to potential adverse effects from PFOA exposure.</p> |
| <b>Laboratory animals</b>  | <p>One way to learn about the effects of perfluoroalkyls is to see how they affect test animals.</p> <p>Birth defects were seen in mice born to females exposed to relatively high amounts of PFOS during pregnancy.</p> <p>Exposure to PFOA and PFOS has resulted in increased early death and delayed development of mice and rat pups, but this did not occur in animals exposed to PFBA or PFHxS.</p>   |
| <b>Human breast milk</b>   | <p>Perfluoroalkyl compounds have been found in the breast milk of women, but there are no studies that looked at whether the health of the babies was affected by drinking this milk. Levels of perfluoroalkyls in breast milk are much lower than in the mother's blood indicating that these substances are not concentrated during the production of mother's milk.</p>  |

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### 1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO PERFLUOROALKYLS?

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| <b>Consumer products</b> | Families may choose to use products that do not contain perfluoroalkyls.  |
| <b>Drinking water</b>    | Families whose tap or well water that contains perfluoroalkyls may choose to drink or cook with bottled water or to install activated carbon water filters. |

### 1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO PERFLUOROALKYLS?

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| <b>Detecting exposure</b> | <p>Perfluoroalkyl compounds can be measured in blood, but this is not a routine test that can be performed in a doctor's office. You should, however, see a physician if you believe that you have been exposed to high levels of perfluoroalkyls.</p> <p>Perfluoroalkyls have been measured in blood samples from a representative sample of the U.S. general population; mean serum PFOA and PFOS concentrations were reported to be 3.9 and 20.7 µg/L, respectively.</p> <p>Elevated serum PFOA levels were reported in Little Hocking, Ohio, community residents who had environmental exposure to PFOA from a nearby industrial facility through contaminated drinking water; the median serum PFOA concentration was 354 µg/L.</p> <p>Higher serum perfluoroalkyl concentrations have been reported in fluorochemical product workers. Mean serum PFOA and PFOS levels for 263 employees in a Decatur, Alabama, 3M facility were 1,780 and 1,320 µg/L, respectively.</p> |
| <b>Measuring exposure</b> | <p>The presence of perfluoroalkyl compounds in your blood may indicate that you have been exposed to and absorbed perfluoroalkyls into your body.</p> <p>The presence of perfluoroalkyl compounds in your blood does not necessarily mean that you will suffer adverse health effects. Additional studies are needed to help determine the health effects associated with exposure to perfluoroalkyls. There are a number of studies underway that should help to answer questions about the health effects of perfluoroalkyls.</p>  |

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#### 1.9 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations *can* be enforced by law. The EPA, the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA) are some federal agencies that develop regulations for toxic substances. Recommendations provide valuable guidelines to protect public health, but *cannot* be enforced by law. The Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH) are two federal organizations that develop recommendations for toxic substances.

Regulations and recommendations can be expressed as doses, intakes, or amounts in air, water, and food that are expected to be safe, usually based on levels that affect animals. Sometimes these not-to-exceed levels differ among federal organizations because they used different exposure times (an 8-hour workday or a 24-hour day), different animal studies, or other factors.

Recommendations and regulations are also updated periodically as more information becomes available. For the most current information, check with the federal agency or organization that provides it. The U.S. EPA (2009) provisional drinking water advisory for PFOA and PFOS are 0.4 and 0.2 µg/L, respectively.

#### 1.10 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department, or contact ATSDR at the address and phone number below.

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ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses that result from exposure to hazardous substances.

Toxicological profiles are also available on-line at [www.atsdr.cdc.gov](http://www.atsdr.cdc.gov) and on CD-ROM. You may request a copy of the ATSDR ToxProfiles™ CD-ROM by calling the toll-free information and technical assistance number at 1-800-CDCINFO (1-800-232-4636), by e-mail at [cdcinfo@cdc.gov](mailto:cdcinfo@cdc.gov), or by writing to:

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1600 Clifton Road NE  
Mailstop F-62  
Atlanta, GA 30333  
Fax: 1-770-488-4178

Organizations for-profit may request copies of final Toxicological Profiles from the following:

National Technical Information Service (NTIS)  
5285 Port Royal Road  
Springfield, VA 22161  
Phone: 1-800-553-6847 or 1-703-605-6000  
Web site: <http://www.ntis.gov/>

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